Inquiry and Investigation
Lesson Plan

Name: Brad Talbert
Contact Information: Pleasant Grove HS, 700 E 200 S, Pleasant Grove, 84062
talbb779@alpine.k12.ut.us

Course Name: Physics

Core Curriculum Standard Fulfilled

Standard IV: Students will understand transfer and conservation of energy

Core Curriculum Objective Fulfilled

Objective 2: Describe conservation of energy in terms of systems.

Intended Learning Outcomes (ILOs) Fulfilled

1. Use science process and thinking skills.
    a. Observe objects, events and patterns and record both qualitative and quantitative information.
    b. Plan and conduct experiments in which students may:
        - Predict results of investigations based upon prior data.
        - Identify variables and describe the relationships between them.
        - Plan procedure to control independent variables.
        - Collect data on the dependent variable(s).
        - Select the appropriate format (e.g., graph, chart, diagram) and use it to summarize the data obtained.
        - Analyze data, check it for accuracy and construct reasonable conclusions.
        - Prepare written and oral reports of investigations.
    h. construct models, simulations and metaphors to describe and explain natural phenomena.
    i. Use mathematics as a precise method for showing relationships.
3. Demonstrate understanding of science concepts, principles, and systems.
    a. Know and explain science information specified for the subject being studied.
    c. Apply principles and concepts of science to explain various phenomena.
    d. Solve problems by applying science principles and procedures.
4. Communicate effectively using science language and reasoning.

a. Provide relevant data to support their inferences and conclusions.
b. Use precise scientific language in oral and written communications.
e. Use mathematical language and reasoning to communicate information.

Time Needed To Complete Inquiry: Approximately 45-90 minutes.

Inquiry: What is the research question to be scientifically investigated and how will your students actively participate? How will you use Guided Inquiry, Semi-guided Inquiry, or Open Inquiry as your teaching method?

How can a heavy weight be dropped on an egg without breaking it? Students will gather information about a spring or elastic cord which will be used to control a heavy falling weight so that it 'kisses' a raw egg without breaking the shell.

This is an open inquiry activity. Students will use what they know about conservation of energy to determine the properties of the elastic medium and then use this knowledge to physically set up the elastic, weights, and egg as directed.

Students should suspend various weights from the elastic media given them in order to obtain data of force vs. resulting stretch of the medium. A graph of force (y-axis) vs. stretch (x-axis) will yield a great deal of useful information. For this activity, the area of the graph is most useful. The area represents the amount of elastic potential energy stored by the medium for various amounts of stretch.

When students have enough information (or think they do) about the elastic medium given to them, I tell them the weight of a heavy mass that they must place on their elastic medium and drop from an unstretched position at some height above the egg. They must determine the height from which to drop the weight. I do not give them the egg before they are ready for their 'official trial' but I do allow them to measure its dimensions if they desire to. When the trial is run with the egg to be 'kissed', the gravity potential energy of the weights above the top of the egg must be converted to elastic potential energy.

Careful measurements are really necessary for successfully complete this activity. Those students who have hasty or careless technique will find that they either miss the egg entirely or that they crack it significantly.

Assessment: How will you know that your students have met the objective? Are there application extensions to this activity, interpretative test items, etc.?

The egg will be the evidence. If the weight leaves a mark (I attach carbon paper to the weight) on the egg with out breaking the shell, students have succeeded. Minor cracks and absolute smashes indicate lesser degrees of success.

Prior Knowledge Needed: What background knowledge and skills do the students need to be prepared for this inquiry? How will they obtain it?

Students need to have knowledge of conservation of energy and how to determine the energy stored by an elastic medium.

Introduction: Tell how you will introduce the inquiry to your students to make it meaningful and relevant.

They are rescue workers who must bungee jump from a bridge in order to rescue a climber stranded on some rocks below. The idea is that they will descend on the bungee cord, and at the lowest point, they will snatch the climber from the rocky ledge. Too much cord and they will smash themselves on the rocks, too little, and they will not reach the climber.

Raw eggs will be used to represent the climber, and a heavy weight the rescuer. Carbon paper attached to the bottom of the weight will leave a 'kiss' mark on the egg's shell indicating a successful rescue. No mark means no rescue, and cracks or destruction of the egg represent that the rescuer now needs rescuing.

Materials / Resources Needed for the Investigation:

Eggs – one per lab group. I bring my own; students sometimes boil them thus thwarting the lab.

Elastic material – either springs from the hardware store or elastic cord from a sewing supplies store. You can also purchase bungee cords of different diameters on-line.

Weights – some for students to use to determine the elastic qualities of their cords and a set to use as the 'rescuer'.

Carbon paper – one smallish piece taped to the bottom of the rescue weights.

Support stand – you can suspend the springs/cords from a ring stand assembly of hold them against the ceiling or find some way that works.

Plastic bags – this is to contain the mess of broken eggs.

Rulers – some way to measure lengths of cords and height of suspended weights.

Procedures of the Investigation: Describe the actual investigation. What will the students do? If applicable, identify the independent and dependent variables, the constants, and the repeated trials.

Students will start by applying varying amounts of weight to the elastic or spring and measuring the corresponding change of length. Some may choose to drop various weights from different heights to determine the length stretched to

before coming to a stop. Several methods are possible and appropriate.

I do not tell students the weight of the 'rescuer' in advance. The weight of the 'rescuer' is usually more than the total of the weights students are allowed to use for their tests. I do not give students their eggs before they are ready to perform the actual feat. This prevents dry runs and falsified procedures/results.

When they tell me that they are ready, I let them measure their egg (I keep possession of it), and I tell them the weight of the 'rescuer'. They use the information they have collected to predict the length the cord will stretch to and thus the height above the egg it must be placed.

When all is ready, students suspend the rescuer from the cord and drop the weight from the cord's unstretched position. This is the moment of truth and the excitement level is high.

Data Collection: How will students collect and organize data (tabulation)?

Students will collect data by measuring lengths and forces. They can feed this into their calculators or a computer to create graphs, charts, and/or equations describing the elastic behavior of the spring/cord and allowing them to make accurate predictions for unknown values.

Data Analysis: How will students be able to interpret the data (e.g., graphs), to reach consensus (if appropriate)? How will they draw conclusions?

Graphs are the most useful. The area of a force-stretch graph gives the amount of energy stored by the medium as it stretches. This is directly related to the gravity potential energy that must be 'used up' to allow the weight to 'kiss' the egg without cracking the shell.

Closure: How will you provide closure to the experience? How will students effectively communicate what they learned?

The proof is in the pudding. The state of the eggs after all groups have gone is the grand finale. Students are usually highly engaged and motivated to do well. For those that demolish eggs or miss entirely, we have a class debriefing following the 'rescue' attempt. This allows me to clarify missed concepts and weird math errors. I suppose you could always celebrate by cooking breakfast afterwards.